APPENDIX A CONNECTION ASSESSMENT

ATCO Simonette 733S Transformer Upgrade
RP-05-1581

The attached engineering study report has been prepared by a third party as part of the AESOs connection process. The AESO has reviewed the report and the conclusions that it contains, and finds it acceptable for the purpose of assessing potential impacts of the proposed connection on the transmission system.

Information regarding the AESO's connection process can be found at: http://www.aeso.ca/8602.html

Date: November 20, 2015

Function	Name	Company	Signature	Date
Senior Engineer	Liuzhong Shi, P.Eng.	Alberta Electric System Operator	Liuzhong Shi	Nov 20, 2015
Manager, Projects & System Access Studies	Mohamed Kamh, Ph.D., P.Eng.	Alberta Electric System Operator		Nov-20, 2015

While the DFO's plans are considered during the transmission planning process, the AESO, in exercising it's duties to plan the transmission system, does not oversee distribution planning or the development of specific DFO planning criteria.

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Connection Engineering Study Report for AUC Application

Simonette 733S Transformer Upgrade Capacity Increase

File No. 1581

Revision: 1

Revision Date: 2015-11-19

	Name	Date	Signature
Prepared and Approved by:	Hugo Murici Ayres, P. Eng.	Nov. 19, 2015	PROFESSIONAL ENGINEER HUGO MURICI AYRES ALBERTA Hugo M. Ayres Nov. 19, 2015

APEGA Permit to Practice P0850

Executive Summary

Project Overview

ATCO Electric Ltd. (ATCO), in its capacity as the legal owner of distribution facilities (DFO), has received multiple industrial load requests in the vicinity of the Town of Fox Creek. The DFO has submitted a system access service request (SASR) to the Alberta Electric System Operator (AESO). The SASR includes a Rate DTS, *Demand Transmission Service*, contract capacity increase from approximately 7.44 MW to 16.8 MW for the system access service provided at the existing Simonette 733S substation, and a request for transmission development (collectively, the Project). The DFO also requested upgrades to the existing Simonette 733S substation.

The in-service date (ISD) for the Project is scheduled for September 9, 2016.

This report presents the results of the study that assesses the impact of the Project on the Alberta interconnected electric system (AIES).

Existing System

The Project is geographically located in the AESO planning area of Grande Cache (Area 22), which is part of the AESO Northwest (NW) Region.

From a transmission system perspective, the H.R. Milner generation facility, with connection to the H.R. Milner 740S substation in the Grande Cache area, connects to the AIES through two 144 kV transmission lines: Transmission line 7L20 connects the H.R. Milner 740S substation to the Big Mountain 845S substation in the Grande Prairie planning area (Area 20); and transmission line 7L80 connects the H.R. Milner 740S substation to the Simonette 733S substation, also located in the Grande Cache area, which further connects to the Little Smoky 813S substation in the Valleyview planning area (Area 23) via transmission line 7L40.

The existing constraints in the NW Region are managed in accordance with Section 302.1 of the ISO rules, *Real Time Transmission Constraint Management*.

Study Summary

Study area for the Project

The study area for the Project consists of the Grande Cache area and the tie lines connecting the Grande Cache area to the rest of the AIES. All transmission facilities within the Grande Cache area were studied and were monitored for violations of the *Transmission Planning Criteria – Basis and Assumptions* (Reliability Criteria). The tie lines connecting the Grande Cache area to the rest of the AIES (7L20 and 7L80) were also studied and were monitored for violations of the Reliability Criteria.

Studies performed for the Project

Power flow analysis was performed for the 2016 winter peak (WP) pre-connection scenario and for the 2016 WP and 2017 summer peak (SP) post-connection scenarios.

Voltage stability analysis was performed only for the 2016 WP post-connection scenario.

Short-circuit analysis was performed for the 2016 WP pre- and post-connection scenarios and for the 2024 WP post-connection scenario to determine the short-circuit levels in the vicinity of the Simonette 733S substation.

Results of the pre-connection studies

No Reliability Criteria violations were observed for the pre-connection study scenario.

Connection alternatives examined for the Project

ATCO, as the DFO in the area northwest of the Town of Fox Creek, examined and ruled out the use of a distribution-based solution to serve the multiple industrial load requests. This report examined two transmission alternatives to serve the Project load increase.

Alternative 1: Upgrade the existing Simonette 733S substation by replacing the existing 10/13 MVA 144/25 kV transformer and associated 10/13 MVA voltage regulator with a 144/25 kV LTC transformer with a minimum transformation capacity of 18.7 MVA, and by replacing the existing 144 kV circuit switcher with a 144 kV breaker.

Alternative 2: Upgrade the existing Simonette 733S substation by adding a 144/25 kV LTC transformer with a minimum transformation capacity of 18.7 MVA, and by adding a 144 kV breaker.

For both alternatives, a transformer size of 30/40/50 MVA would be recommended based on good electric industry practice and under advisement from the legal owner of transmission facilities (TFO) regarding their asset management and inventory practices.

Connection alternative selected for further examination

Alternative 1 was selected for further study. Alternative 2 involves greater transmission system development compared to Alternative 1 and was not selected for further study.

Results of the post-connection studies

Category A (N-G-0) conditions

Under Category A conditions, no Reliability Criteria violations were observed for any of the studied scenarios with Alternative 1.

Category B (N-G-1) contingency conditions

Under Category B contingency conditions, no Reliability Criteria violations were observed for any of the studied scenarios with Alternative 1.

Conclusions and Recommendation

Based on the study results, Alternative 1 is technically viable. It is recommended to proceed with the Project using Alternative 1 as the preferred alternative.

Contents

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1. Introduction

This Project Engineering Study Report presents the results of the study that assesses the impact of the Project (as defined below) on the Alberta interconnected electric system (AIES).

1.1. Project

1.1.1. Project Overview

ATCO Electric Ltd. (ATCO), in its capacity as the legal owner of distribution facilities (DFO), has received multiple industrial load requests in the vicinity of the Town of Fox Creek. The DFO has submitted a system access service request (SASR) to the Alberta Electric System Operator (AESO). The SASR includes a Rate DTS, *Demand Transmission Service*, contract capacity increase from approximately 7.44 MW to 16.8 MW for the system access service provided at the existing Simonette 733S substation, and a request for transmission development (collectively, the Project). The DFO also requested upgrades to the existing Simonette 733S substation.

The in-service date (ISD) for the Project is scheduled for September 9, 2016.

1.1.2. Load Component

The Project includes the requested Rate DTS contract capacity increase from 7.4418 MW to 16.8 MW for the system access service provided at the existing Simonette 733S substation.

The requested load increase will be studied using an expected power factor of 0.90 lagging.

1.1.3. Generation Component

There is no generation component associated with the Project.

1.2. Study Scope

1.2.1. Study Objectives

The objective of the study is as follows:

- Assess the impact of the Project connection on the AIES.
- Evaluate the Project connection alternatives.
- Recommend the Project connection alternative and any mitigation measures to address system performance concerns, if any, to enable the reliable integration of the Project into the AIES.

1.2.2. Study Area

1.2.2.1. Study Area Description

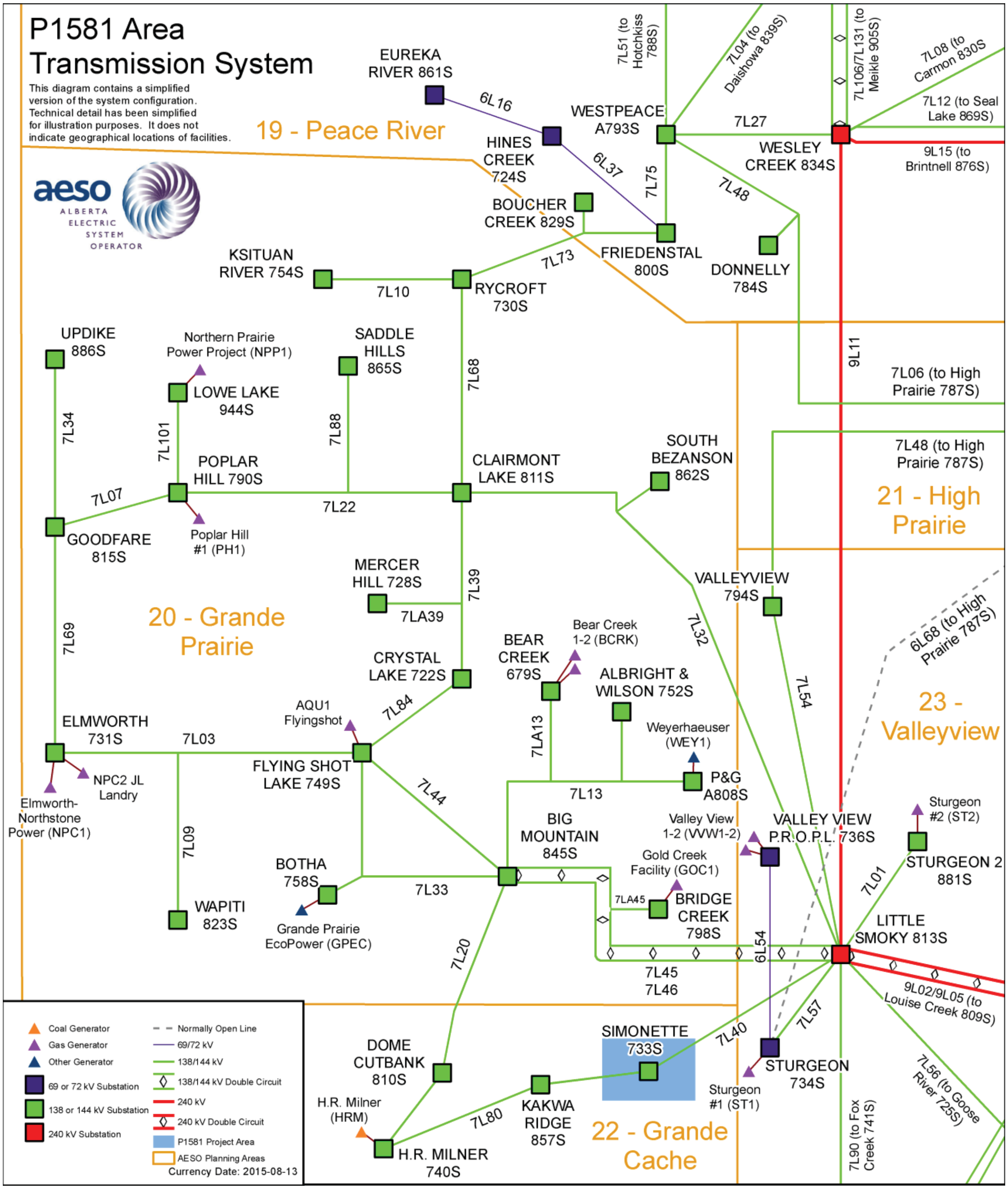
The Project is geographically located in the AESO planning area of Grande Cache (Area 22), which is part of the AESO Northwest (NW) Region.

From a transmission system perspective, the H.R. Milner generation facility, with connection to the H.R. Milner 740S substation in the Grande Cache area, connects to the AIES through two 144 kV transmission lines: Transmission line 7L20 connects the H.R. Milner 740S substation to the Big Mountain 845S substation in the Grande Prairie planning area (Area 20); and transmission line 7L80 connects the H.R. Milner 740S substation to the Simonette 733S substation, also located in the Grande Cache area, which further connects to the Little Smoky 813S substation in the Valleyview planning area (Area 23) via transmission line 7L40.

The study area for the Project consists of the Grande Cache area and the tie lines connecting the Grande Cache area to the rest of the AIES. All transmission facilities within the Grande Cache area were studied and were monitored for violations of the *Transmission Planning Criteria – Basis and Assumptions* (Reliability Criteria). The tie lines connecting the Grande Cache area to the rest of the AIES (7L20 and 7L80) were also studied and were monitored for violations of the Reliability Criteria.

Figure 1-1 shows the existing study area transmission system.

Figure 1-1: Study Area Single Line Diagram



1.2.2.2. Existing Constraints

The existing constraints in the NW Region are managed in accordance with Section 302.1 of the ISO rules, *Real Time Transmission Constraint Management* (TCM Rule).

1.2.2.3. AESO Long-Term Plans

The *AESO 2015 Long-term Transmission Plan* (2015 LTP) identifies the following system developments that are in the vicinity of the study area and that are needed for the near term (2020 time frame):

- Add new 240 kV line from Little Smoky substation to Big Mountain substation south of Grande Prairie
- Expand Big Mountain substation to include 240 kV facilities
- Add new 144 kV line from Big Mountain substation to Poplar Hill substation northwest of Grande Prairie
- Add voltage support at Big Mountain substation
- Add voltage support in Rycroft area
- Add voltage support at Thornton and other Grande Cache area substations

1.2.3. Studies Performed

The following studies were performed:

- Power flow analysis (Category A conditions and Category B contingencies);
- Voltage stability analysis (Category A conditions and Category B contingencies);
- Short-circuit analysis (Category A conditions).

1.3. Report Overview

The Executive Summary provides a high-level summary of the report and its conclusions. Section 1 provides an introduction of the Project. Section 2 describes the criteria, system data, and study assumptions used in this study. Section 3 presents the study methodology used in this study. Section 4 discusses the pre-connection system assessment. Section 5 presents the connection alternatives examined. Section 6 provides a technical analysis of the post-connection system assessment for the alternatives selected for further study. Section 7 provides a short-circuit analysis of the pre- and post-connection. Section 8 discusses project interdependencies. Section 9 presents the conclusions and recommendations of this study.

2. Criteria, System Data, and Study Assumptions

2.1. Criteria, Standards, and Requirements

2.1.1. Transmission Planning Standards and Criteria

The Transmission Planning (TPL) Standards, which are included in the Alberta Reliability Standards, and the AESO's Reliability Criteria[1] were applied to evaluate system performance under Category A system conditions (i.e., all elements in-service) and following Category B contingencies (i.e., single element outage), prior to and following the studied alternatives. Below is a summary of Category A and Category B system conditions.

Category A, often referred to as the N-0 condition, represents a normal system with no contingencies and all facilities in service. Under this condition, the system must be able to supply all firm load and firm transfers to other areas. All equipment must operate within its applicable rating, voltages must be within their applicable range, and the system must be stable with no cascading outages.

Category B events, often referred to as an N-1 or N-G-1 with the most critical generator out of service, result in the loss of any single specified system element under specified fault conditions with normal clearing. These elements are a generator, a transmission circuit, a transformer, or a single pole of a DC transmission line. The acceptable impact on the system is the same as Category A. Planned or controlled interruptions of electric supply to radial customers or some local network customers, connected to or supplied by the faulted element or by the affected area, may occur in certain areas without impacting the overall reliability of the interconnected transmission systems. To prepare for the next contingency, system adjustments are permitted, including curtailments of contracted firm (non-recallable reserved) transmission service electric power transfers.

The TPL standards, TPL-001-AB-0 and TPL-002-AB-0 have referenced Applicable Rating when specifying the required system performance under Category A, and Category B events. For the purpose of applying the TPL standards to the studies documented in this report, Applicable Ratings are defined as follows:

- Seasonal continuous thermal rating of the line's loading limits.
- Highest specified loading limits for transformers.
- For Category A conditions: Voltage range under normal operating condition per AESO Information Document ID# 2010-007RS. For the busses not listed in ID#2010-007RS, Table 2-1 in the Reliability Criteria applies.
- For Category B conditions: The extreme voltage range values per Table 2-1 in the Reliability Criteria.

[1] Filed under a separate cover

- Desired post-contingency voltage change limits for three defined post event timeframes as provided in Table 2-1, below.

Table 2-1: Post-Contingency Voltage Deviations Guidelines for Low Voltage Busses

Parameter and reference point	Time Period		
	Post Transient (Up to 30 sec.)	Post Auto Control (30 sec. to 5 min.)	Post Manual Control (Steady State)
Voltage deviation from steady state at low voltage bus	±10%	±7%	±5%

2.1.2. AESO Information Documents (IDs), Operating Policies and Procedures (OPPs) and Authoritative Documents (ADs)

The AESO Voltage Control Practice ID # 2010-007RS will be applied to establish pre-contingency voltage profiles in the study region. The TCM Rule will be followed in setting up the study scenarios and assessment of the connection impact. In addition, due regard will be given to the AESO Customer Connection Study Requirements Document and the Generation and Load Interconnection Standard.

The Reliability Criteria is the basis for planning the AIES. The transmission system will normally be designed to meet or exceed the Reliability Criteria under credible worst-case loading and generation conditions.

2.2. Load and Generation Assumptions

The study area and region forecasts used for this connection study are based on the *AESO 2014 Long-term Outlook* (2014 LTO).

2.2.1. Load Assumptions

Table 2-2 presents the load conditions and assumptions used in the connection studies. In this study the active power to reactive power ratio in the Base Cases was maintained when modifying the loads.

Table 2-2: Load Forecast (2014 LTO at AIL Peak)

Area	Description	2016 WP	2017 SP
22	Grande Cache	55.5	53.8
NW Region	Northwest	1,368.5	1,271.4
AIL	AIL w/o losses	12,154.0	11,440.4

2.2.2. Generation Assumptions

The conditions of the generators that are in the vicinity of the Project are described in Table 2-3. The study assumed the H.R. Milner Generator as the critical generator and is turned off to represent the N-G study condition in the Grand Cache area for all the study cases except for the short-circuit analysis.

Table 2-3: Generation Dispatch

Plant Name	Bus Number	Area	Capacity (MW)	2016 WP (MW)	2017 SP (MW)
BCR2	19142_2	20	36	12	12
BCRK	18142_1	20	64	44	0
GOC1	19145_1	20	5	0	0
GPEC	17101_2	20	27	18	11
HRM	1148_1	22	144	OFF	OFF
NPC1	17134_5, 17134_6, 18134_7, 18134_8, 21134_10	20	20	0	0
WEY1	1146_1A	20	48	41	34

2.2.3. Intertie Flow Assumptions

The intertie points are deemed to be too far away to have an effect on the assessment of the proposed connection. The flows in the study area are not influenced by the AIES HVDC facilities. As a result, the intertie and HVDC assumptions are kept consistent with that in the AESO planning base cases and not adjusted for this study.

2.3. System Projects

No system projects were included in the study.

2.4. Customer Connection Projects

Table 2-4 identifies customer connection projects in the study area.

Table 2-4: Customer Connection Projects in the Study Area

Area	Year	Project no.	Project Name	Additional MW	Queue Position***
22	2017*	1581 (the Project)	ATCO Simonette Transformer Upgrade	9.36	76
22	2016	1634	ATCO Thornton New POD Phase 1**	17.9	101

* 2017 is based on the DFO's requested ISD in the SASR. As discussed in Section 1, the scheduled ISD for the Project is September 9, 2016.
** ATCO has indicated that it may request additional Rate DTS contract capacity increases to 25.4 MW (Phase 2) in November 2017 and to 42 MW (Phase 3) in August 2018.
*** Per the AESO Connection Queue posted on November 2015.

Project 1634 was not included in this study due to its position in the AESO Connection Queue, regardless of its ISD and the filing date of the needs identification document (NID) relating to P1634. The connection assessment for the NID relating to P1634 had considered both P1634 and the Project, and any remedial action schemes proposed for P1634 would be sufficient to address the impact of the loads associated with both P1634 and the Project on the transmission system.

2.5. Facility Ratings and Shunt Elements

Table 2-5 provides the ratings of the existing key transmission lines in the study area and adjacent to the study area.

Table 2-5: Main Transmission Lines in the Study Area (138 kV Base)

Transmission Line	Summer (MVA)	Winter (MVA)
7L20 Big Mountain 845S – Dome Cutbank 810S	143.8	143.8
7L40 Little Smoky 813S – Simonette 733S	109.3	139.0
7L80 H.R. Milner 740S – Simonette 733S	109.3	139.0

Table 2-6 provides the shunt element information in the study area and key shunt information located in the adjacent areas.

Table 2-6: Summary of Reactive Elements in the Study Area

Station Name and Number	Voltage (kV)	Capacitor (MVAr)	Reactor (MVAr)	SVC (MVAr)	Synchronous Condenser (MVAr)
Big Mountain 845S	144	1 x 30	-	-	-
HR Milner 740S	25	1 x 5.4	-	-	-
Little Smoky 813S	144	3 x 30	-	-	-
	34.5	-	-	+/- 100	-
	25	-	2 x 20		

2.6. Voltage Profile Assumptions

The voltages at the key buses in the study scenarios for the area under study for this Project are shown in Table 2-7. The desired voltage ranges as provided in the AESO ID# 2010-007RS were used to set the study base cases voltages prior to power flow analysis.

Table 2-7: Summary of the Voltage at Key Nodes in the Study Area

Substation	Nominal Voltage (kV)	ID# 2010-007RS			Voltage in the Study Case (kV) N-0-G		
					Pre-Connection	Post-Connection Alternative 1	
		Minimum Operating Limit (kV)	Desire Range (kV)	Maximum Operating Limit (kV)	2016 WP	2016 WP	2017 SP
Rycroft 730S	144	136.8	142.6-154.1	155	149.3	149.2	149.3
H.R. Milner 740S	144	144	146-150	151	146.1	146.4	146.3
Crystal Lake 722S	144	144	147-151	155	150.7	150.6	150.5
Flyingshot Lake 749S	144	144	147-151	155	150.0	149.9	149.9
Poplar Hill 790S	144	142	144-151	155	150.6	150.5	150.1
Clairmont Lake 811S	144	144	147-151	155	150.8	150.7	150.7
Little Smoky 813S	240	255	257-268	275	264.7	264.7	265.3
	144	146	148-152	155	151.0	151.0	151.0
Goodfare 815S	144	142	144-151	155	148.2	148.1	148.9
Big Mountain 845S	144	145	147-151	155	150.0	149.8	149.8

3. Study Methodology

All the studies were completed using PTI PSS/E version 33.

3.1. Study Objectives

The objectives of the study are the following:

- Assess the impact of the Project connection on the AIES.
- Evaluate the Project connection alternatives.
- Recommend the Project connection alternative and any mitigation measures to address system performance concerns, if any, to enable the reliable integration of the Project into the AIES.

3.2. Study Scenarios

The 2016 WP and 2017 SP conditions were studied for the Project. The 2024 WP condition was only considered to determine the short-circuit levels for the long-term assessment.

Table 3-1: Project Study Cases

Scenarios	Year / Condition	Simonette 733S Load	System Generation Dispatch Conditions
1	2016 WP (Pre-connection)	7.44 MW	Economic
2	2016 WP (Post-connection)	16.8 MW	Economic
3	2017 SP (Post-connection)	16.8 MW	Economic
4	2024 WP (Post-connection)	16.8 MW	As per published base case

Please note the critical generator identified for this study was the H.R. Milner unit. The power flow and voltage stability analyses were performed with this generator out-of-service.

3.3. Connection Studies Carried Out

The following studies were carried out for this connection study.

Table 3-2: Summary of Studies Performed

Scenario(s) Studied	Critical Generator Status	Studies Performed	System conditions studied
1, 2, 3	OFF	Power flow	Category A and B
2	OFF	Voltage stability	Category A and B
1, 2, 4	ON	Short-circuit	Category A

3.4. Power Flow Analysis

Power flow analysis was performed to identify any thermal overloads or transmission voltage violations, as per the Reliability Criteria, and to identify any deviations from the desired limits in Table 2-1. The purpose of the power flow analysis is to quantify any incremental violations that are observed following the connection of the Project.

Point of delivery (POD) low voltage bus deviations were also assessed by first locking all tap changers and area capacitors to identify any post-transient voltage deviations above 10%. Tap changers were then allowed to move while capacitors remained locked to determine if any voltage deviations above 7% were found in the area. Once all taps and capacitor controls were allowed to adjust, voltage deviations above 5% were reported for both the pre-connection and post-connection networks.

3.4.1. Contingencies Studied

Power flow analysis was performed for Category A conditions and all Category B contingencies in the study area, including the tie lines connecting the study area to surrounding planning areas, for Scenarios 1, 2 and 3.

3.5. Voltage Stability (PV) Analysis

Voltage stability analysis was performed according to the Western Electricity Coordinating Council (WECC) Voltage Stability Assessment Methodology. WECC voltage stability criteria states, "for load areas, post-transient voltage stability is required for the area modeled at a minimum of 105% of the reference load level for system normal conditions (Category A) and for single contingencies (Category B)". For this standard, the reference load level is the maximum established planned load.

The reference load level is the maximum forecasted load for the Grande Cache area. The Wabamun planning area (Area 40) was used as the remote generation source for the voltage stability analysis.

The objective of the PV curve is to determine the ability of the network to maintain voltage stability at all the busses in the system under normal and abnormal system conditions. The PV curve is a representation of voltage change as a result of increased power transfer between two systems. The reported incremental transfers will be to the collapse point. As per the AESO requirements, no assessment based upon other criteria such as minimum voltage will be made at the PV minimum transfer.

3.5.1. Contingencies Studied

Voltage stability analysis was performed for Category A conditions and all Category B contingencies in the study area, including the tie lines connecting the study area to surrounding planning areas, only for the post-connection winter peak scenario.

3.6. Short-Circuit Analysis

Short-circuit analysis was performed for the 2016 WP pre- and post-connection scenarios, as well as for the long-term assessment using the AESO 2024 WP planning base case. All transmission elements were assumed to be in service and all expected transmission system generation dispatched according to the year of study.

4. Pre-Connection System Assessment

4.1. Pre-Connection Power Flow Analysis

Under Category A conditions and Category B contingency conditions, no Reliability Criteria violations were observed for the 2016 WP pre-connection scenario. The power flow PSS/E single line diagrams are provided in Attachment A.

4.1.1. Scenario 1 – 2016 WP

No thermal overloads, voltage violations or POD bus voltage deviations were found for the Category A condition or any of the Category B contingencies studied.

5. Connection Alternatives

5.1. Overview

ATCO, as the DFO in the area northwest of the Town of Fox Creek, examined and ruled out the use of a distribution-based solution to serve the multiple industrial load requests.[2]

This report examines two transmission alternatives to serve the Project load increase.[3]

5.2. Connection Alternatives Examined

Below is a description of the developments associated with each transmission alternative examined for the Project.

Alternative 1 – Replace the existing transformer at the Simonette 733S substation

Alternative 1 involves upgrading the existing Simonette 733S substation by replacing the existing 10/13 MVA 144/25 kV transformer and associated voltage regulator with a transformer of higher capacity, and by replacing the existing 144 kV circuit switcher with a 144 kV breaker.

This alternative includes:

[2] The DFO's report detailing this analysis is included in section 4 of the ATCO *Distribution Deficiency Report, Simonette 733S*, which is filed under a separate cover.

[3] These alternatives reflect more up to date engineering design than the alternatives identified in the ATCO *Distribution Deficiency Report, Simonette 733S*, which is filed under a separate cover.

- Replace the existing 10/13 MVA 144/25 kV transformer and associated 10/13 MVA voltage regulator with one 144/25 kV LTC transformer with a minimum transformation capacity of 18.7 MVA (based on Rate DTS request of 16.8 MW at 0.9 power factor).
- Replace the existing 144 kV circuit switcher with one 144 kV breaker and associated equipment, since it has better performance and aligns with the maintenance practices of the legal owner of transmission facilities (TFO).

Alternative 2 – Add a transformer at the Simonette 733S substation

Alternative 2 involves upgrading the existing Simonette 733S substation by adding a second 144/25 kV transformer, and by adding a 144 kV breaker.

The transmission development includes the following:[4]

- Add one 144/25 kV LTC transformer with a minimum transformation capacity of 18.7 MVA;
- Add one 144 kV breaker and associated equipment

For both alternatives, a transformer size of 30/40/50 MVA would be recommended based on good electric industry practice and under advisement from the TFO regarding their asset management and inventory practices.

5.2.1. Connection Alternatives Selected for Further Studies

Alternative 1 was selected for further studies.

5.2.2. Connection Alternatives Not Selected for Further Studies

Alternative 2 involves greater transmission system development compared to Alternative 1 and was not selected for further study.

[4] The TFO has advised that the developments for this alternative require expansion of the existing control building, and 25 kV and 144 kV bus reconfigurations, modifications, or additions. The TFO has also advised that the substation would have to be expanded to the south to accommodate the 144 kV bus expansion and that the substation fence is constrained by pipelines.

6. Technical Analysis of the Connection Alternatives

6.1. Alternative 1

6.1.1. Power Flow Analysis

Under Category A conditions and Category B contingency conditions, no Reliability Criteria violations were observed for the two post-connection scenarios that were studied. Power flow diagrams for the Category A conditions and selected Category B contingencies are included in Attachment B.

6.1.1.1. Scenario 2 – 2016 WP

No thermal overloads, voltage violations or POD bus voltage deviations were observed for the Category A condition or any of the Category B contingencies studied.

6.1.1.2. Scenario 3 – 2017 SP

No thermal overloads, voltage violations or POD bus voltage deviations were observed for the Category A condition or any of the Category B contingencies studied.

6.1.2. Voltage Stability Analysis

Voltage stability analysis was performed for the 2016 WP post-connection scenario for Alternative 1. The Category A condition and all Category B contingencies studied met the PV criteria.

6.1.2.1. Scenario 2 – 2016 WP

The reference load level for the Grande Cache area is 55.5 MW. The minimum incremental load transfer for the Category B contingencies is 5.0% or 2.8 MW (0.05 x 55.5 MW = 2.8 MW) to meet the voltage stability criteria.

Table 6-1 summarizes the PV results for the Category A condition and all the Category B contingencies in the area regarding the PV transfer margins. The PV curves are provided in Attachment C.

Table 6-1: Scenario 2 – 2016 WP: Alternative 1 – PV Analysis Results

Contingency	From	To	Maximum incremental transfer (MW)	Meets 105% transfer criteria?
None	System Normal		58.1	Yes
7L20	Big Mountain 845S	H.R. Milner 740S	27.5	Yes
7L40	Little Smoky 813S	Simonette 733S	36.9	Yes
7L80	Little Smoky 813S	H.R. Milner 740S	45.0	Yes

6.1.3. Mitigation Measures for Identified Issues

No mitigation measure is required since no performance issue was identified in the studies.

6.2. Conclusions and Recommendations

Only Alternative 1 was selected for further studies. Based on the study results, Alternative 1 is technically viable. It is recommended to proceed with the Project using Alternative 1 as the preferred alternative.

7. Short-Circuit Analysis

Short-circuit analysis was conducted for the 2016 WP and 2024 WP study cases with all generation in service to provide the maximum short-circuit levels[5] in the vicinity of Simonette 733S substation. The analysis were performed prior to and following the Project connection. Single phase and three phase fault currents were calculated as provided in the following tables. The positive and zero sequence impedances are given in p.u. using base voltage and 100 MVA.

7.1. Pre-Connection – 2016 WP

Table 7-1 provides the 2016 WP short-circuit levels with the existing 10/13 MVA transformer at Simonette 733S substation.

[5] Short-circuit current studies were based on modeling information provided to the AESO by third parties. The authenticity of the modeling information has not been validated. Fault levels could change as a result of system developments, new customer connections, or additional generation in the area. It is recommended that these changes be monitored and fault levels reviewed to ensure that the fault levels are within equipment operating limits. The information provided in this study should not be used as the sole source of information for electrical equipment specifications or for the design of safety-grounding systems.

Table 7-1: Summary of Short-Circuit Current Levels – Pre-Connection (Year 2016 WP)

Substation	Base Voltage[1] (kV)	Nominal Voltage (kV)	Pre-fault Voltage (kV)	3-Φ Fault (kA)	Positive Sequence Thevenin Source Impedance (R1+jX1) (p.u.)[1]	1-Φ Fault (kA)	Zero Sequence Thevenin Source Impedance (R0+jX0) (p.u.)[1]
Big Mountain 845S	138	144	149.06	7.55	0.01672+j0.057431	7.54	0.007378+j0.060711
Dome Cutbank 810S	138	144	147.42	3.83	0.02825+j0.113342	3.09	0.030937+j0.199241
H.R. Milner 740S	138	144	148.65	3.92	0.02402+j0.11253	4.27	0.007676+j0.086597
Little Smoky 813S	240	240	264.99	6.69	0.009348+j0.038585	6.74	0.003091+j0.039
	138	144	150.97	10.12	0.012167+j0.043545	12.80	0.001459+j0.017037
Simonette 733S	138	144	149.58	2.58	0.066205+j0.163149	1.69	0.123566+j0.439209
	25	25	26.20	2.38	0.178356+j0.999801	2.15	0.17644+j1.328318

7.2. Post-Connection

Table 7-2 provides the 2016 WP short-circuit levels with the Project, while Table 7-3 provides the 2024 WP long-term short-circuit levels.

Table 7-2: Summary of Short-Circuit Current Levels – Post-Connection (Year 2016 WP)

Substation	Base Voltage[1] (kV)	Nominal Voltage (kV)	Pre-fault Voltage (kV)	3-Φ Fault (kA)	Positive Sequence Thevenin Source Impedance (R1+jX1) (p.u.)[1]	1-Φ Fault (kA)	Zero Sequence Thevenin Source Impedance (R0+jX0) (p.u.)[1]
Big Mountain 845S	138	144	149.29	7.55	0.016669+j0.057555	7.54	0.00738+j0.060718
Dome Cutbank 810S	138	144	147.50	3.83	0.028276+j0.113347	3.09	0.030987+j0.198773
H.R. Milner 740S	138	144	148.52	3.92	0.024169+j0.112355	4.30	0.007722+j0.08434
Little Smoky 813S	240	240	264.84	6.69	0.009373+j0.038566	6.74	0.003094+j0.038948
	138	144	150.97	10.12	0.012232+j0.043546	12.81	0.001464+j0.016908
Simonette 733S	138	144	148.11	2.58	0.06706+j0.160524	2.57	0.02872+j0.176982
	25	25	25.98	5.84	0.094412+j0.400063	5.50	0.039568+j0.488092

Table 7-3: Summary of Short-Circuit Current Levels – Post-Connection (Year 2024 WP)

Substation	Base Voltage[1] (kV)	Nominal Voltage (kV)	Pre-fault Voltage (kV)	3-Φ Fault (kA)	Positive Sequence Thevenin Source Impedance (R1+jX1) (p.u.)[1]	1-Φ Fault (kA)	Zero Sequence Thevenin Source Impedance (R0+jX0) (p.u.)[1]
Big Mountain 845S	138	144	149.06	10.10	0.010823+j0.043396	9.18	0.007779+j0.058143
Dome Cutbank 810S	138	144	147.66	4.11	0.025503+j0.105964	3.21	0.03106+j0.198492
H.R. Milner 740S	138	144	148.09	4.06	0.022987+j0.108172	4.41	0.007727+j0.084329
Little Smoky 813S	240	240	263.36	9.28	0.006663+j0.027662	10.11	0.00213+j0.02155
	138	144	151.00	11.84	0.009717+j0.037408	14.75	0.001427+j0.015983
Simonette 733S	138	144	148.20	2.65	0.065477+j0.156318	2.62	0.028718+j0.176826
	25	25	25.92	5.90	0.092283+j0.395315	5.54	0.039405+j0.486571

8. Project Interdependencies

No project interdependencies were identified.

9. Conclusions and Recommendations

ATCO, in its capacity as DFO, has received multiple industrial load requests in the vicinity of the Town of Fox Creek. The DFO has submitted a SASR to the AESO, including a request for the Project. The DFO also requested upgrades to the existing Simonette 733S substation.

The ISD for the Project is scheduled for September 9, 2016.

This report presented the results of the study that assesses the impact of the Project on the AIES.

The Project is geographically located in the AESO planning area of Grande Cache (Area 22), which is part of the AESO NW Region. The existing constraints in the NW Region are managed in accordance with the TCM Rule.

Studies performed for the Project

Power flow analysis was performed for the 2016 WP pre-connection scenario and for the 2016 WP and 2017 SP post-connection scenarios.

Voltage stability analysis was performed only for the 2016 WP post-connection scenario.

Short-circuit analysis was performed for the 2016 WP pre- and post-connection scenarios and for the 2024 WP post-connection scenario to determine the short-circuit levels in the vicinity of the Simonette 733S substation.

Results of the pre-connection studies

No Reliability Criteria violations were observed for the pre-connection study scenario.

Connection alternatives examined for the Project

ATCO, as the DFO in the area northwest of the Town of Fox Creek, examined and ruled out the use of a distribution-based solution to serve the multiple industrial load requests. This report examined two transmission alternatives to serve the Project load increase.

Alternative 1: Upgrade the existing Simonette 733S substation by replacing the existing 10/13 MVA 144/25 kV transformer and associated 10/13 MVA voltage regulator with a 144/25 kV LTC transformer with a minimum transformation capacity of 18.7 MVA, and by replacing the existing 144 kV circuit switcher with a 144 kV breaker.

Alternative 2: Upgrade the existing Simonette 733S substation by adding a 144/25 kV LTC transformer with a minimum transformation capacity of 18.7 MVA, and by adding a 144 kV breaker.

For both alternatives, a transformer size of 30/40/50 MVA would be recommended based on good electric industry practice and under advisement from the TFO regarding their asset management and inventory practices.

Connection alternative selected for further examination

Alternative 1 was selected for further study. Alternative 2 involves greater transmission system development compared to Alternative 1 and was not selected for further study.

Results of the post-connection studies

Category A (N-G-0) conditions

Under Category A conditions, no Reliability Criteria violations were observed for any of the studied scenarios with Alternative 1.

Category B (N-G-1) contingency conditions

Under Category B contingency conditions, no Reliability Criteria violations were observed for any of the studied scenarios with Alternative 1.

Based on the study results, Alternative 1 is technically viable. It is recommended to proceed with the Project using Alternative 1 as the preferred alternative.

ATTACHMENT A

Pre-Connection System Power Flow Plots

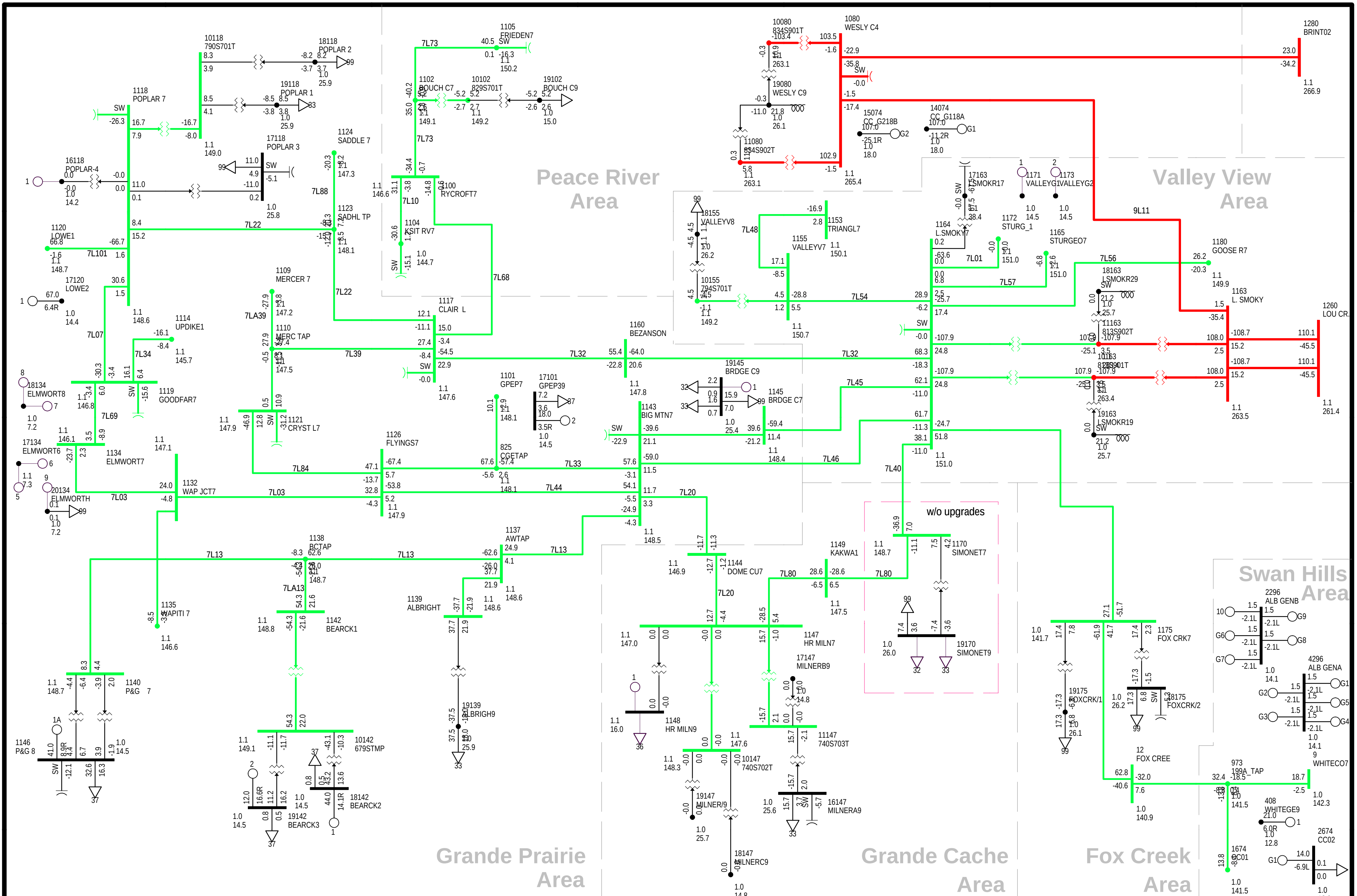
Existing System Power Flow Results

Power Flow Diagrams

The pre-connection power flow diagrams for Category A and selected B contingencies are provided in this section. The following table presents the list of the power flow diagrams. Please note that H.R. Milner generator is turned off for the analyzed case.

Table A-1: List of pre-connection power flow diagrams

Scenario	Power flow diagram	Page number
2016 WP	N-G-0, System Normal Condition	A-3
	N-G-1, Loss of 7L20	A-4
	N-G-1, Loss of 7L40	A-5
	N-G-1, Loss of 7L80	A-6

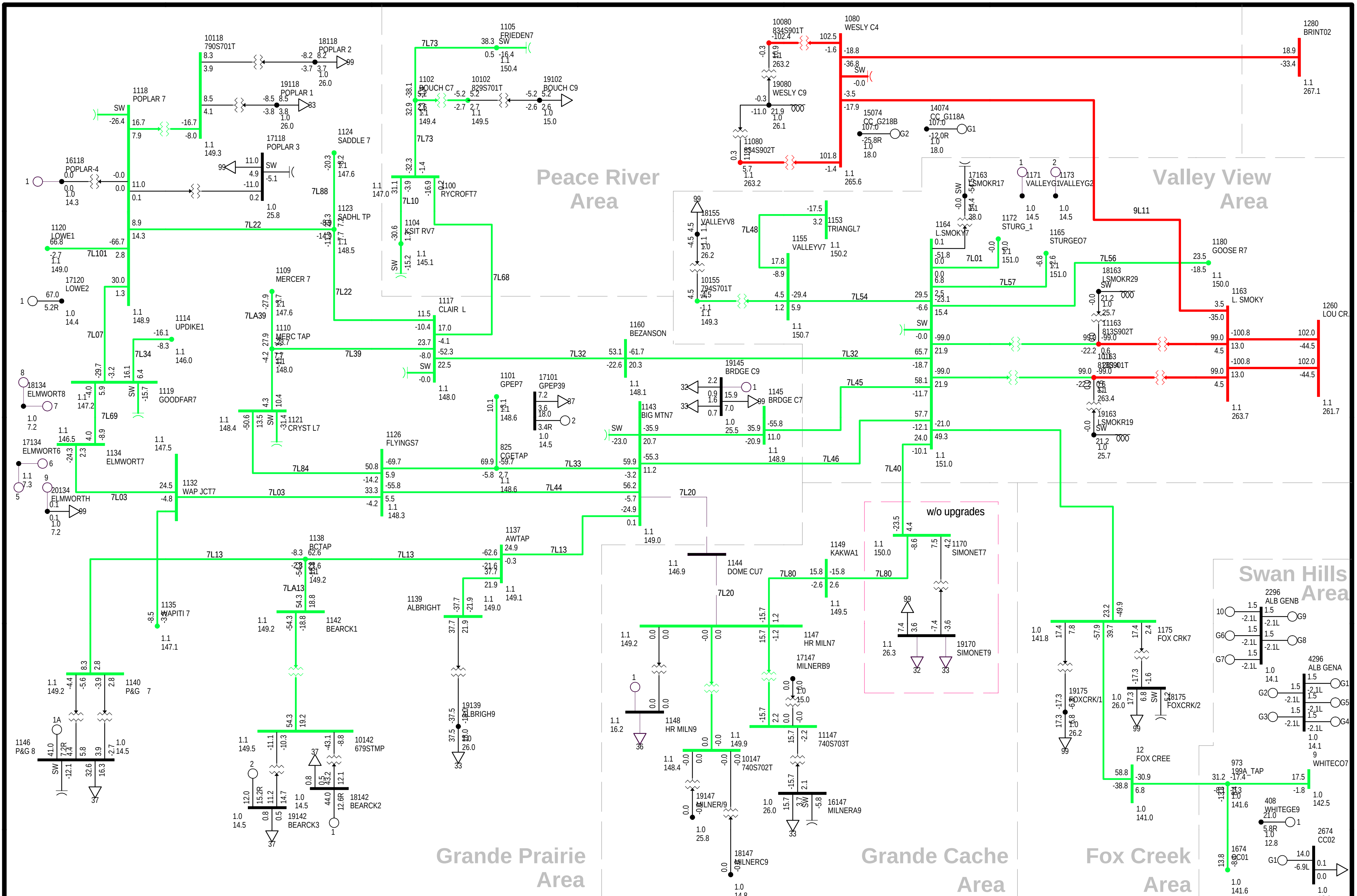


P1581 - Simonette 733S Transformer Upgrade and Capacity Increase

CATEGORY A, N-G-0
2016 WP WITHOUT PROJECT
WED, NOV 26 2014 10:28

Page A- 3

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B
1.120OV 1.000UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000 <=500.000

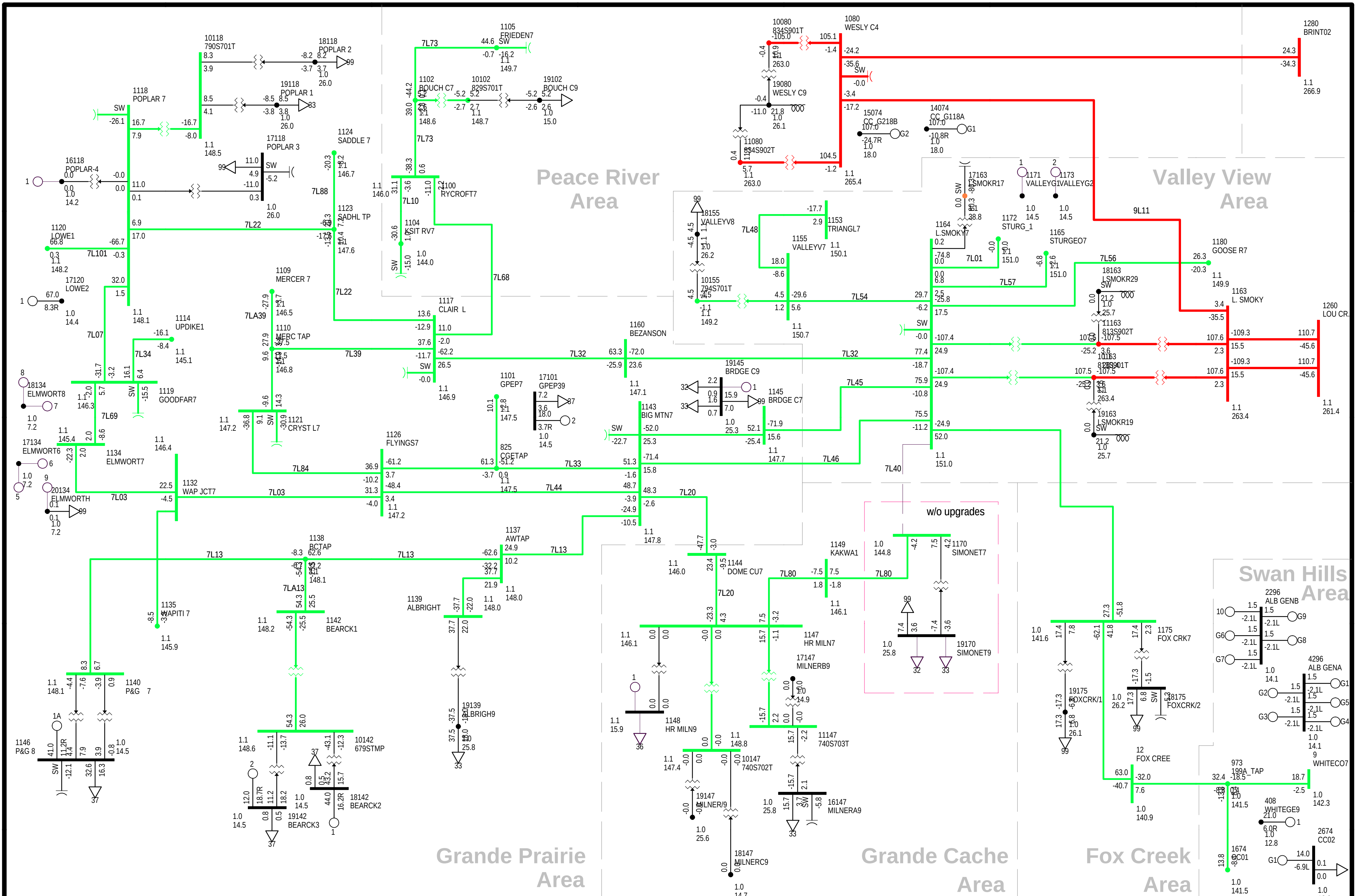


P1581 - Simonette 733S Transformer Upgrade and Capacity Increase

CATEGORY B, LOSS OF 7L20
2016 WP WITHOUT PROJECT
WED, NOV 26 2014 10:28

Page A- 4

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B
1.120OV 1.000UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000 <=500.000

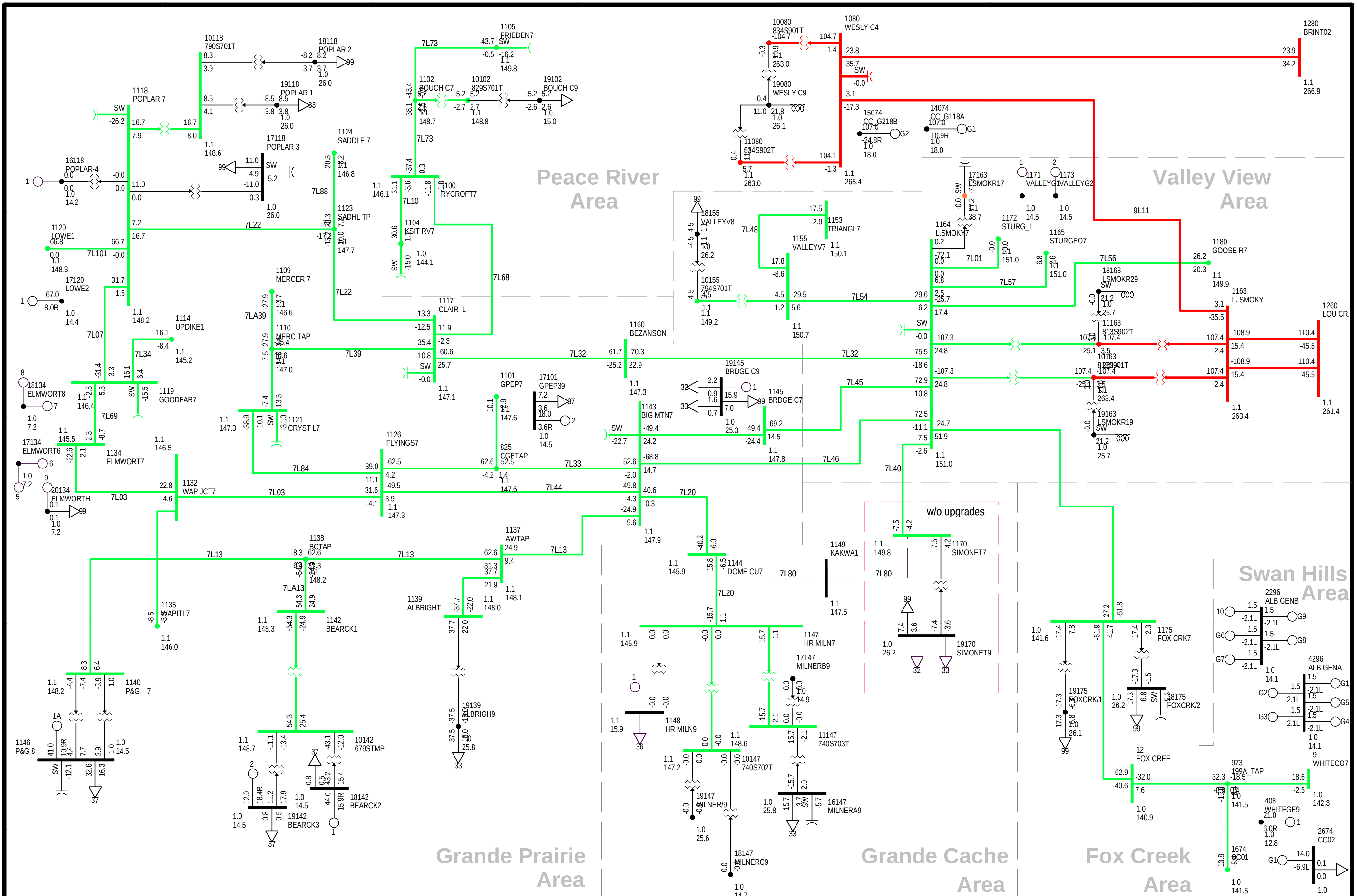


P1581 - Simonette 733S Transformer Upgrade and Capacity Increase

CATEGORY B, LOSS OF 7L40
2016 WP WITHOUT PROJECT
WED, NOV 26 2014 10:28

Page A- 5

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B
1.120OV 1.000UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000 <=500.000



P1581 - Simonette 733S Transformer Upgrade and Capacity Increase

CATEGORY B, LOSS OF 7L80
2016 WP WITHOUT PROJECT
WED, NOV 26 2014 10:28

Page A- 6

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B
1.120OV 1.000UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000 <=500.000

ATTACHMENT B

Post-Connection Alternative 1: System Power Flow Plots

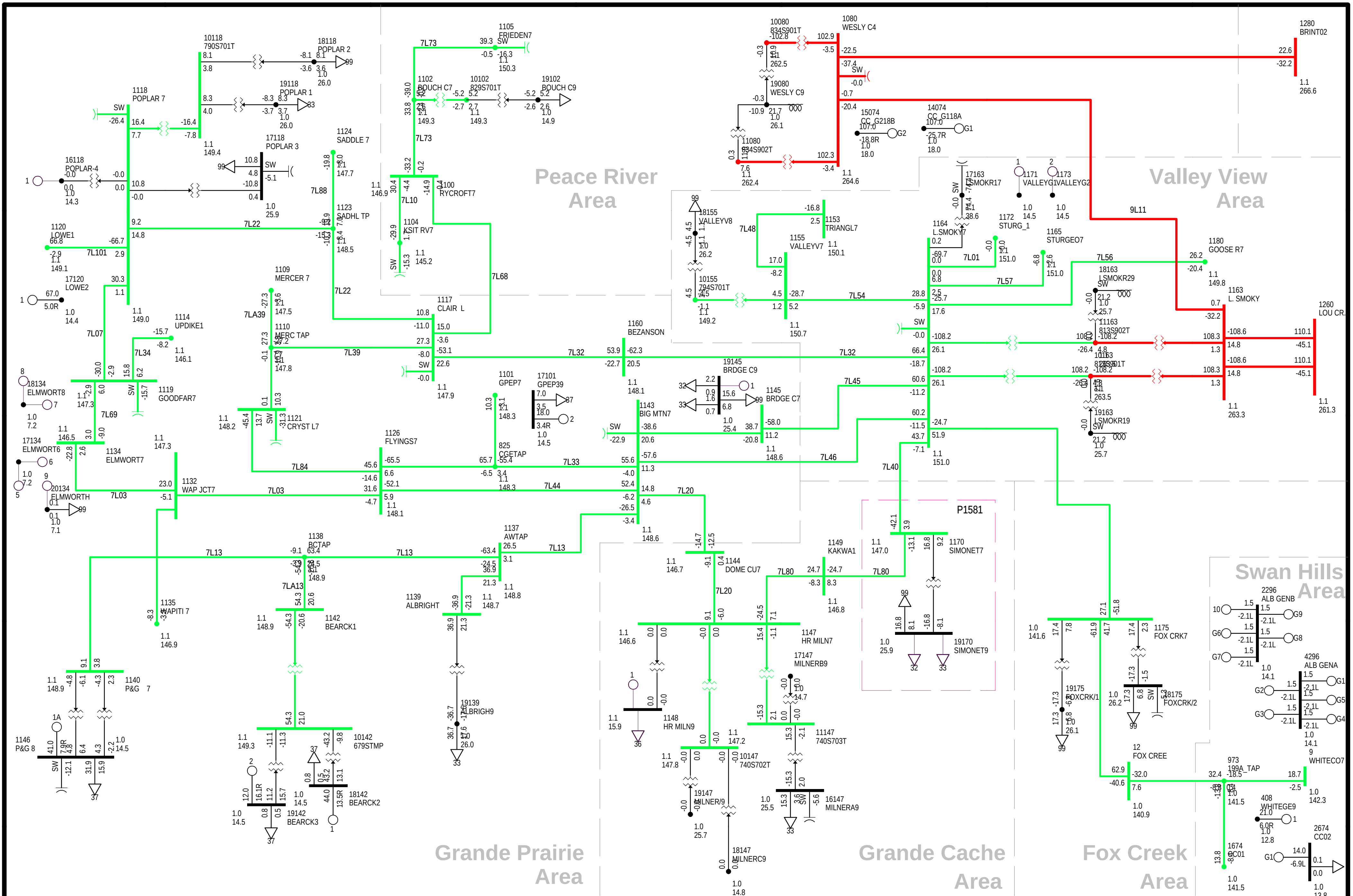
System Power Flow Results

Power Flow Diagrams

The post-connection alternative 1 power flow diagrams for Category A and selected B contingencies are provided in this section. The following table presents the list of the power flow diagrams. Please note that H.R. Milner generator is turned off for the analyzed cases.

Table B-1: List of post-connection alternative 1 power flow diagrams

Scenario	Power flow diagram	Page number
2016 WP	N-G-0, System Normal Condition	B-3
	N-G-1, Loss of 7L20	B-4
	N-G-1, Loss of 7L40	B-5
	N-G-1, Loss of 7L80	B-6
2017 SP	N-G-0, System Normal Condition	B-7
	N-G-1, Loss of 7L20	B-8
	N-G-1, Loss of 7L40	B-9
	N-G-1, Loss of 7L80	B-10

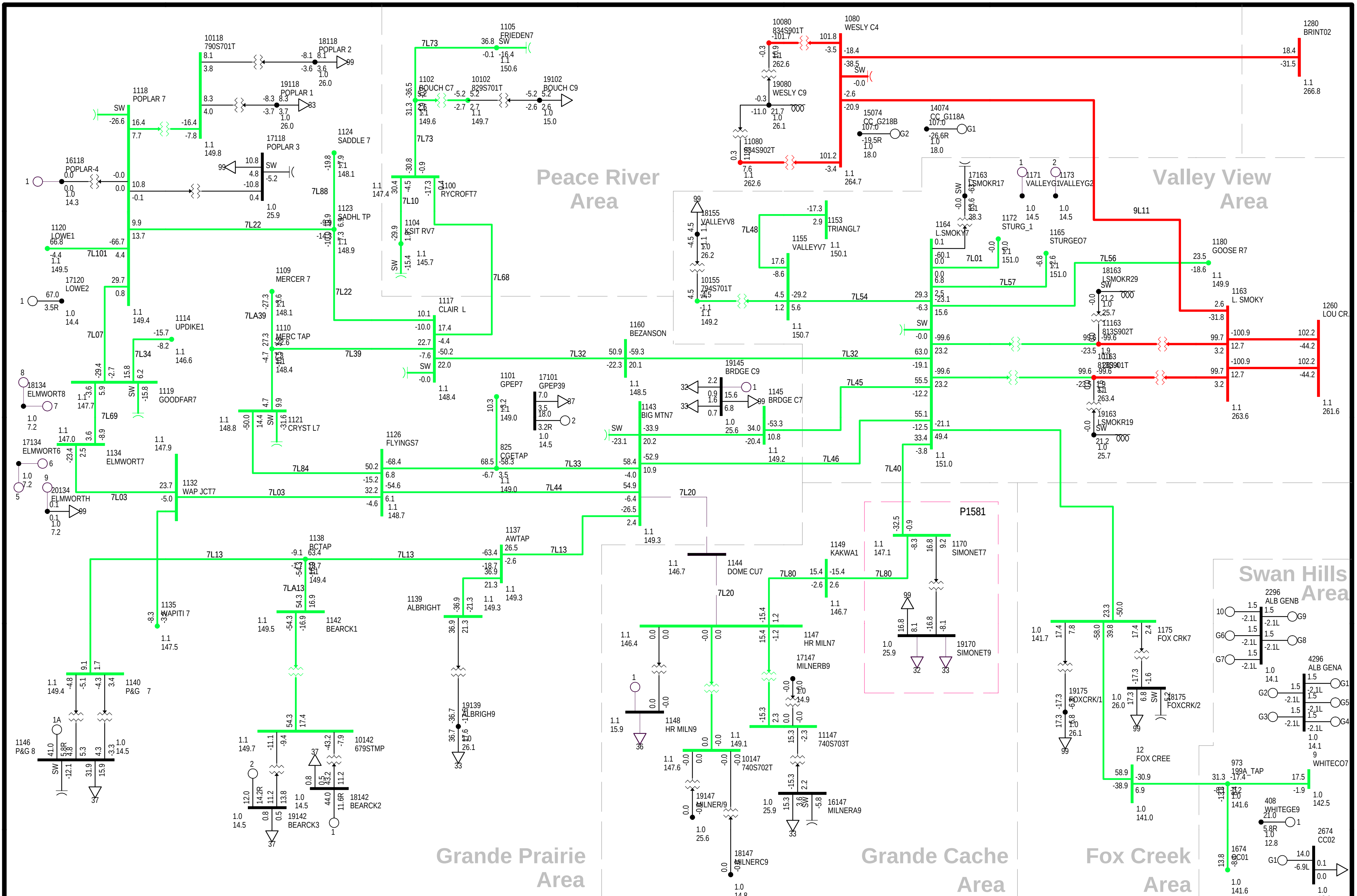


P1581 - Simonette 733S Transformer Upgrade and Capacity Increase

CATEGORY A, N-G-0
2016 WP WITH PROJECT ALTERNATIVE 1
WED, NOV 26 2014 10:30

Page B- 3

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B
1.120OV 1.000UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000 <=500.000

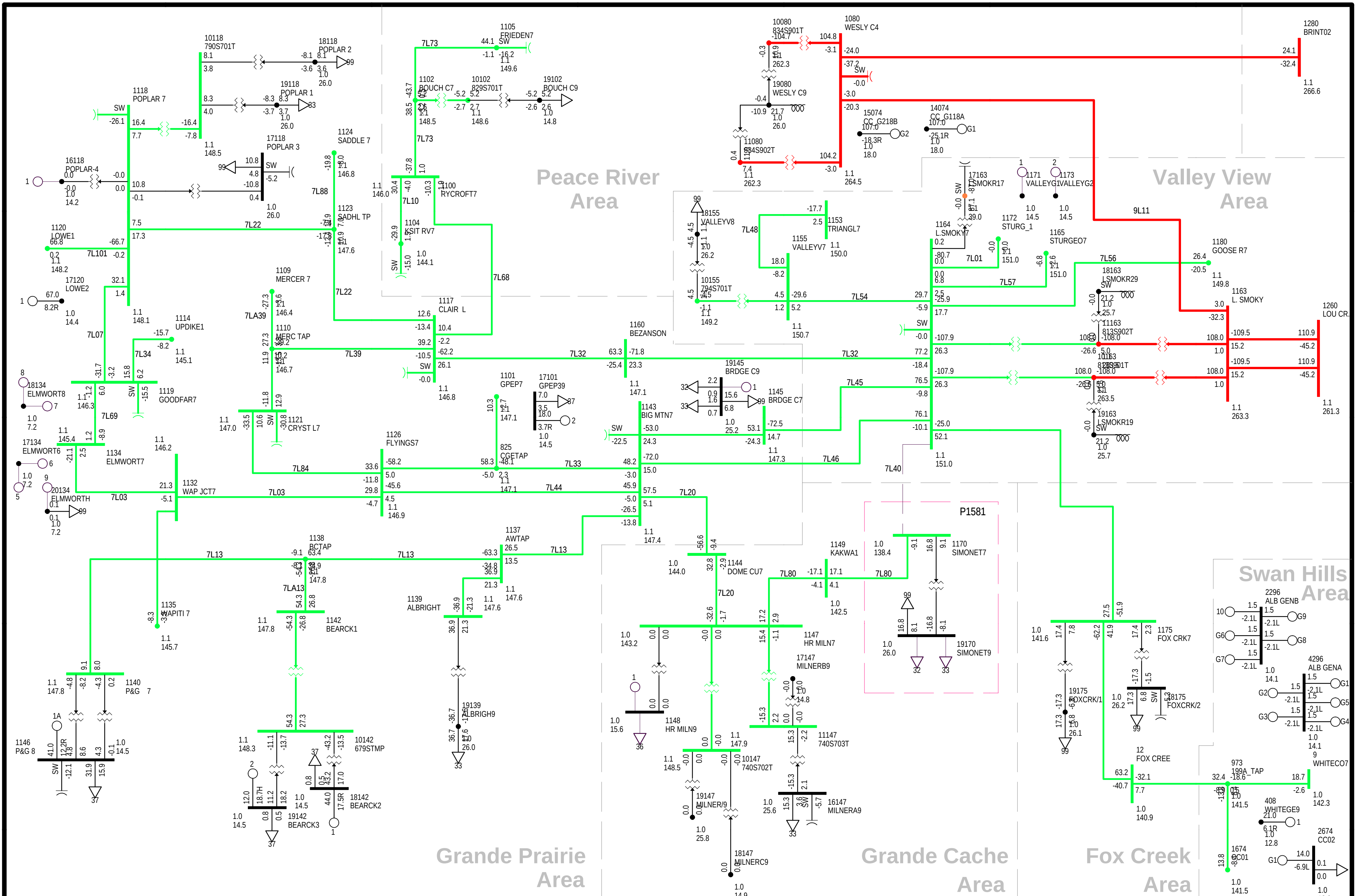


P1581 - Simonette 733S Transformer Upgrade and Capacity Increase

CATEGORY B, LOSS OF 7L20
2016 WP WITH PROJECT ALTERNATIVE 1
WED, NOV 26 2014 10:30

Page B- 4

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B
1.120OV 1.000UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000 <=500.000

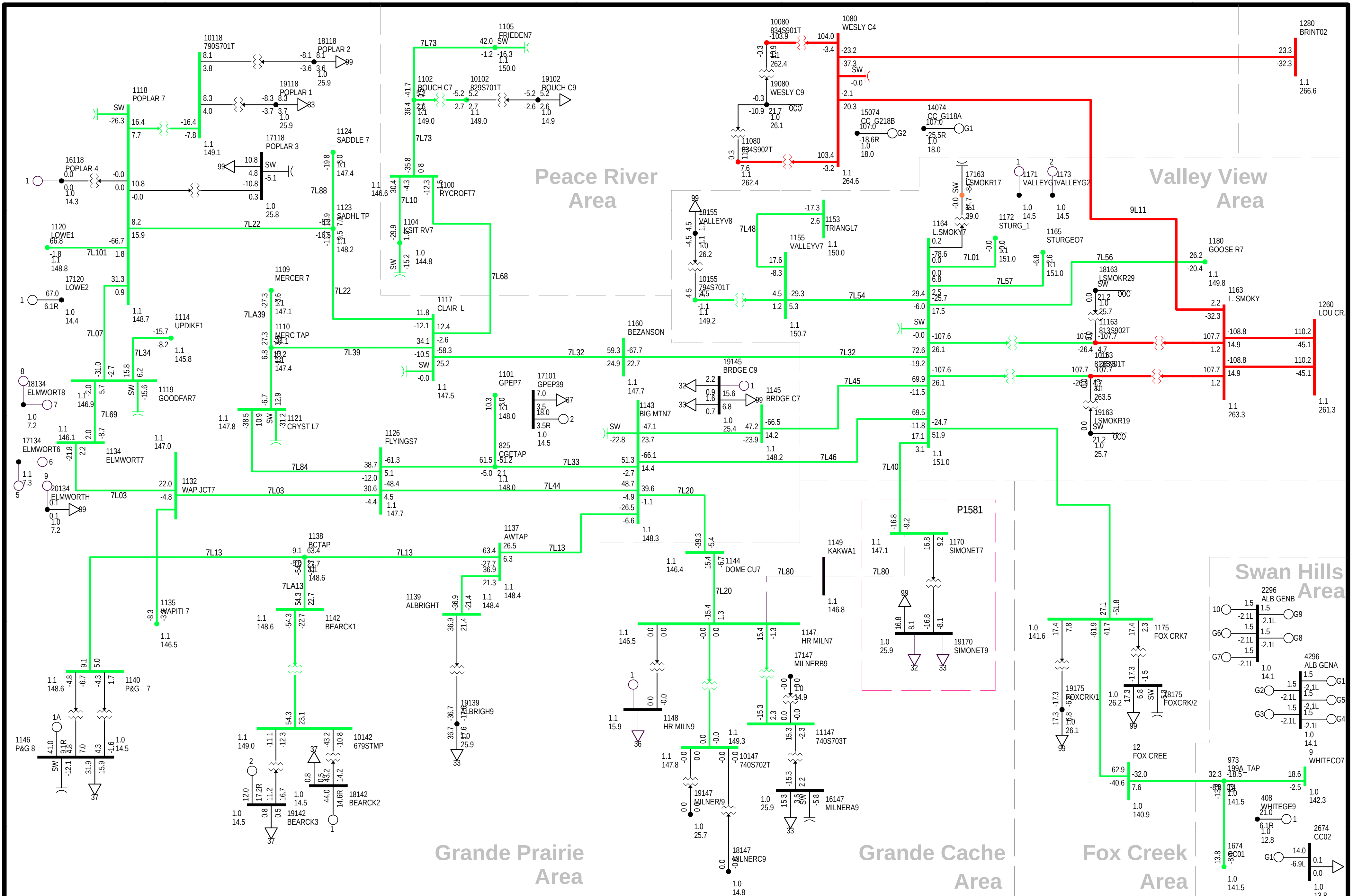


P1581 - Simonette 733S Transformer Upgrade and Capacity Increase

CATEGORY B, LOSS OF 7L40
2016 WP WITH PROJECT ALTERNATIVE 1
WED, NOV 26 2014 10:30

Page B- 5

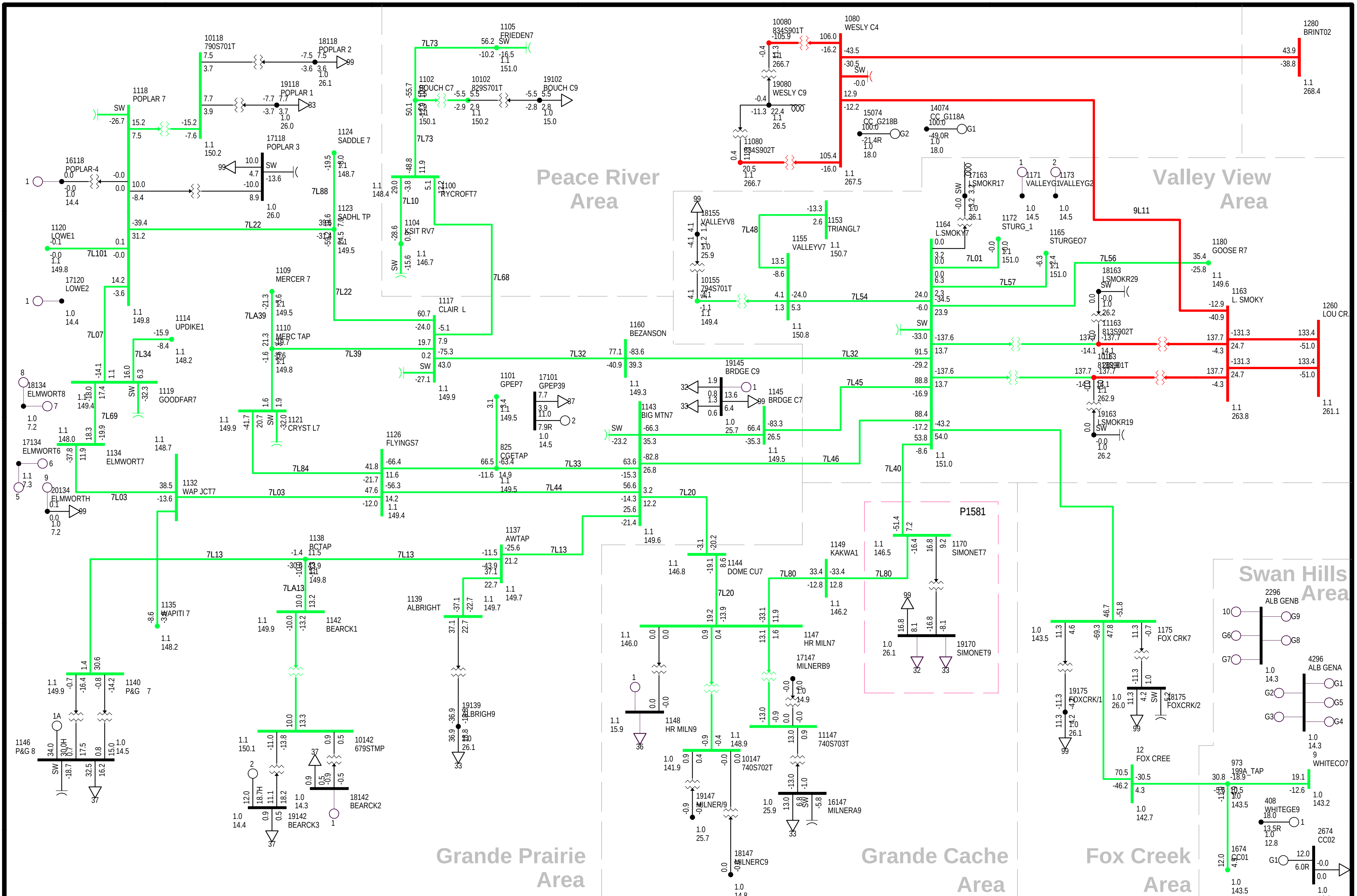
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B
1.120OV 1.000UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000 <=500.000



P1581 - Simonette 733S Transformer Upgrade and Capacity Increase

CATEGORY B, LOSS OF 7L80
2016 WP WITH PROJECT ALTERNATIVE 1
WED, NOV 26 2014 10:31

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate B
1.120OV 1.000UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000 <=500.000

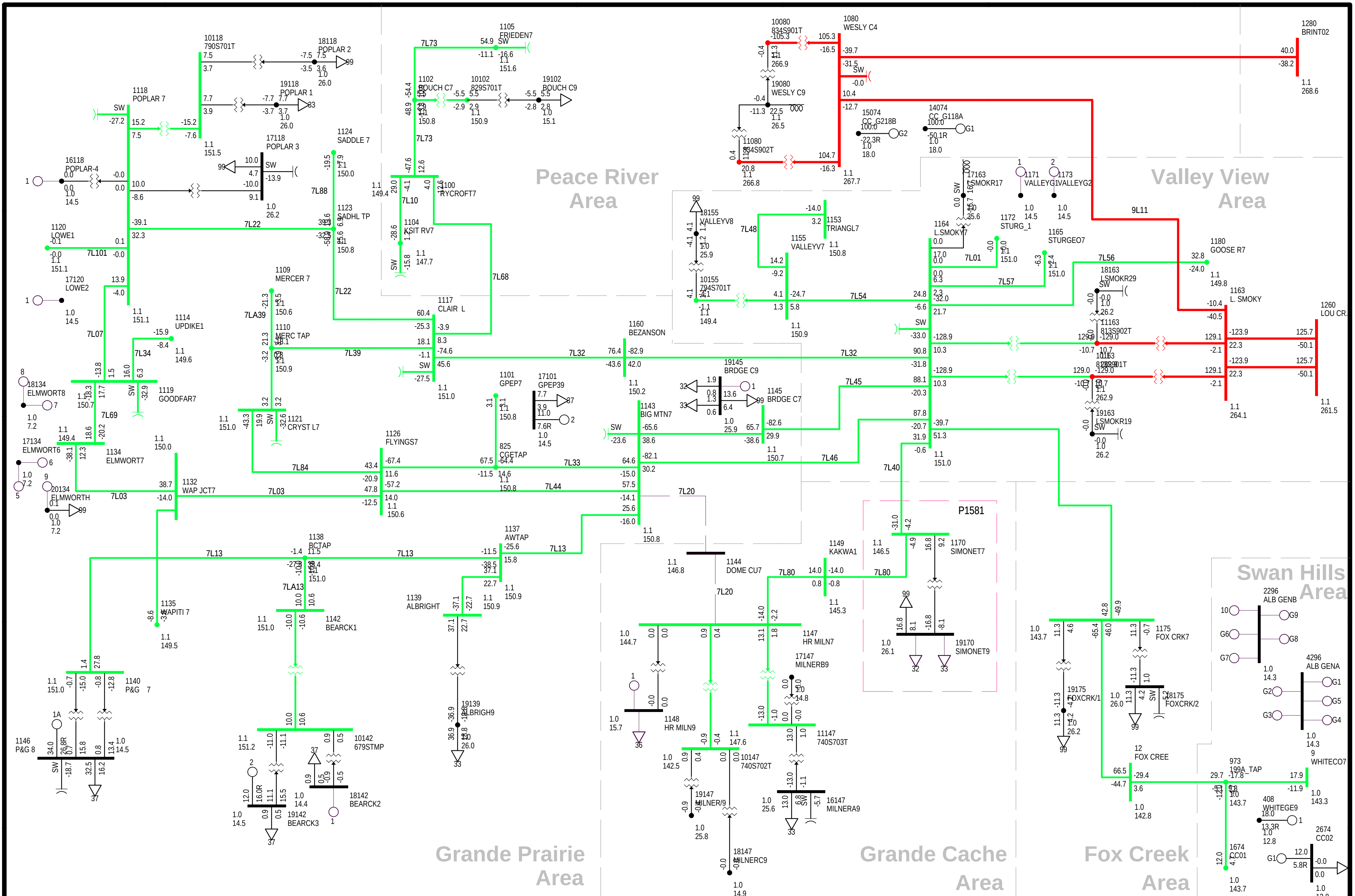


P1581 - Simonette 733S Transformer Upgrade and Capacity Increase

CATEGORY A, N-G-0
2017 SP WITH PROJECT ALTERNATIVE 1
WED, NOV 26 2014 10:32

Page B- 7

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A
1.120OV 1.000UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000 <=500.000

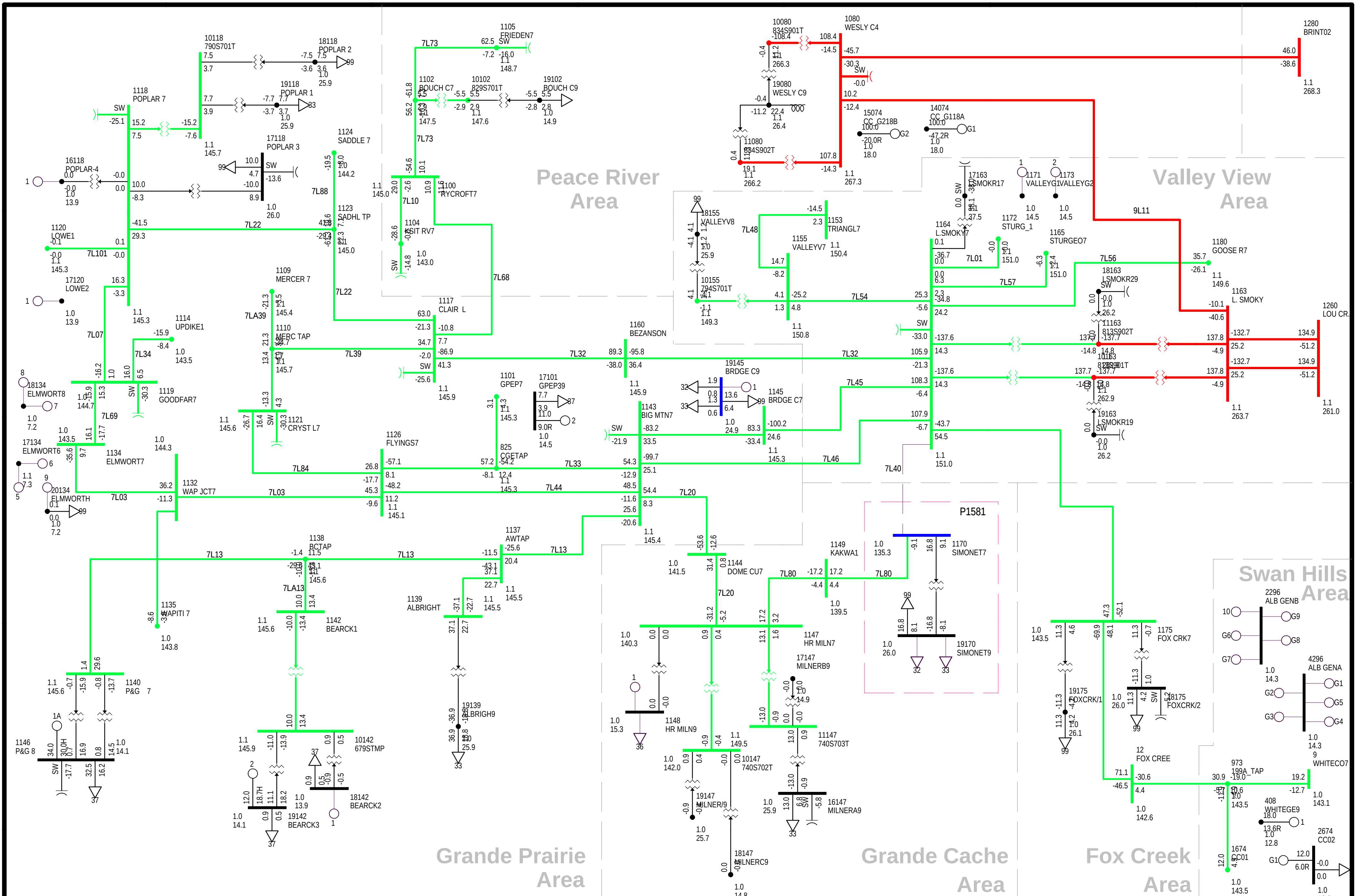


P1581 - Simonette 733S Transformer Upgrade and Capacity Increase

CATEGORY B, LOSS OF 7L20
2017 SP WITH PROJECT ALTERNATIVE 1
WED, NOV 26 2014 10:32

Page B- 8

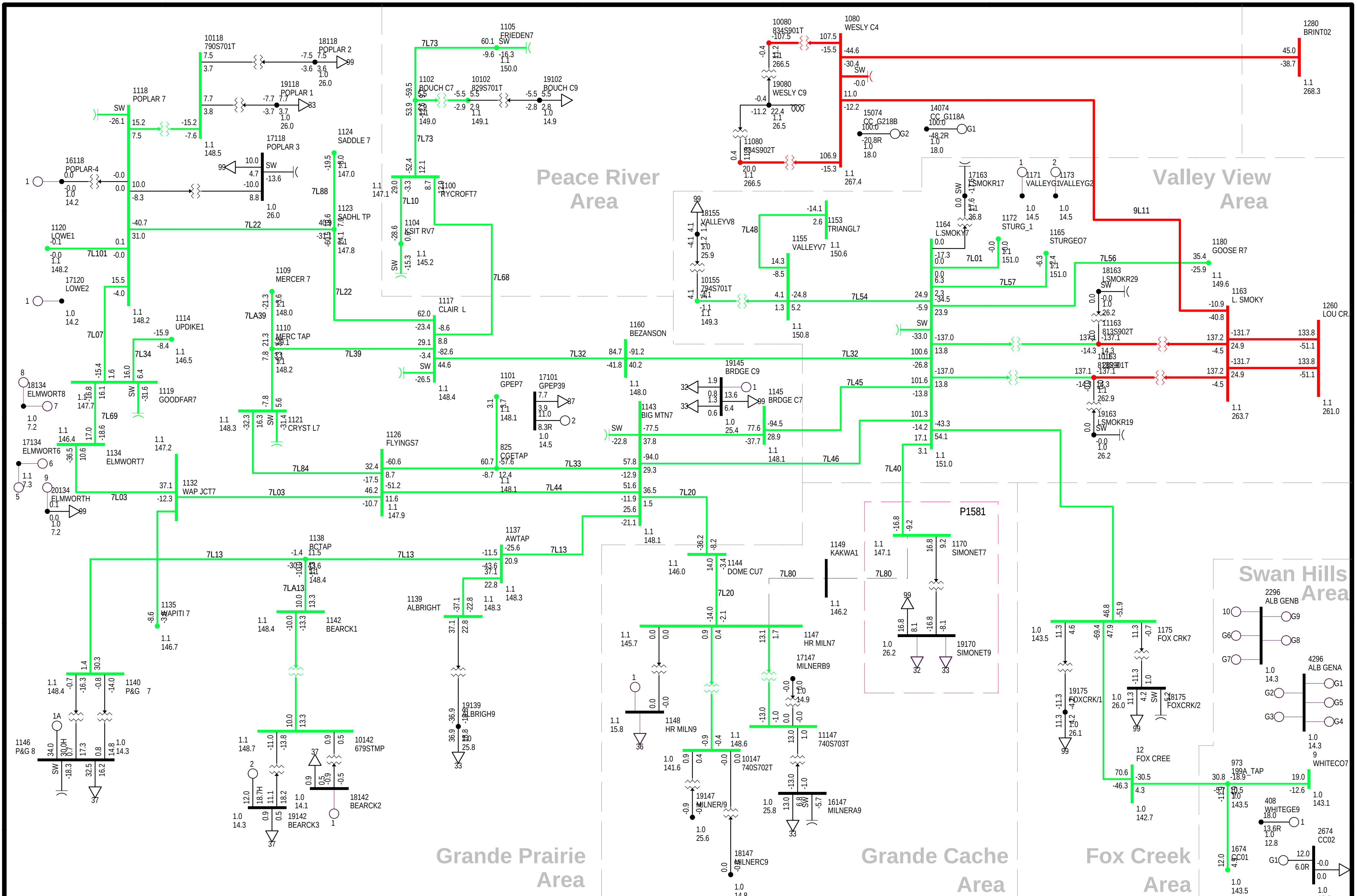
Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A
1.120OV 1.000UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000 <=500.000



P1581 - Simonette 733S Transformer Upgrade and Capacity Increase

CATEGORY B, LOSS OF 7L40
2017 SP WITH PROJECT ALTERNATIVE 1
WED, NOV 26 2014 10:32

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A
1.120OV 1.000UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000 <=500.000



P1581 - Simonette 733S Transformer Upgrade and Capacity Increase

CATEGORY B, LOSS OF 7L80
2017 SP WITH PROJECT ALTERNATIVE 1
WED, NOV 26 2014 10:33

Page B- 10

Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A
1.120OV 1.000UV
kV: >0.000 <=34.500 <=72.000 <=144.000 <=240.000 <=500.000

ATTACHMENT C

Post-Connection Alternative 1 Voltage Stability Analysis: PV Curves

Figures

This attachment provides the PV curves for the 2016 winter peak post-connection scenario. All Category A and B contingencies studied met the PV criteria.

Post-Project 2016 WP – Scenario 2

Figure C-1 through Figure C-3 show PV the curves for all contingencies in this scenario. Assuming the project load connection for this peak scenario, the reference load level for the Grande Cache Area (Area 22) is 55.5 MW. The minimum incremental load transfer for the Category B contingencies is 5.0% or 2.8 MW (0.05 x 55.5 MW = 2.8 MW) to meet the voltage stability criteria.

Figure C-1: PV Curves for the 144 kV Line 7L20 Contingency

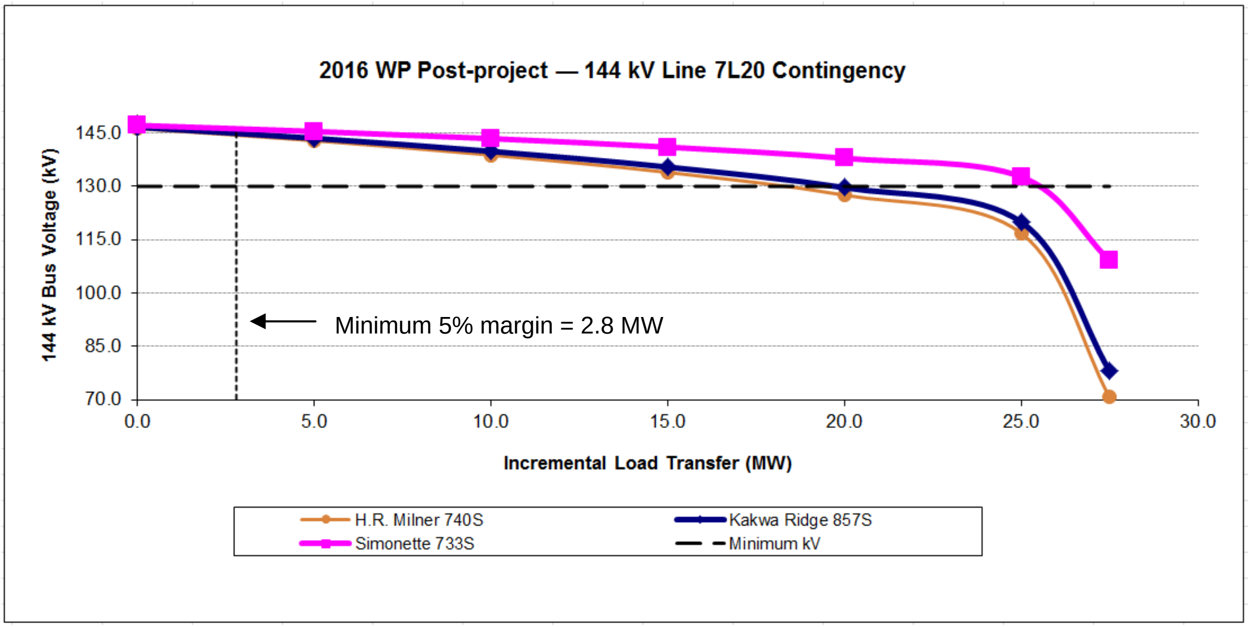


Figure C-2: PV Curves for Line 7L40 Contingency

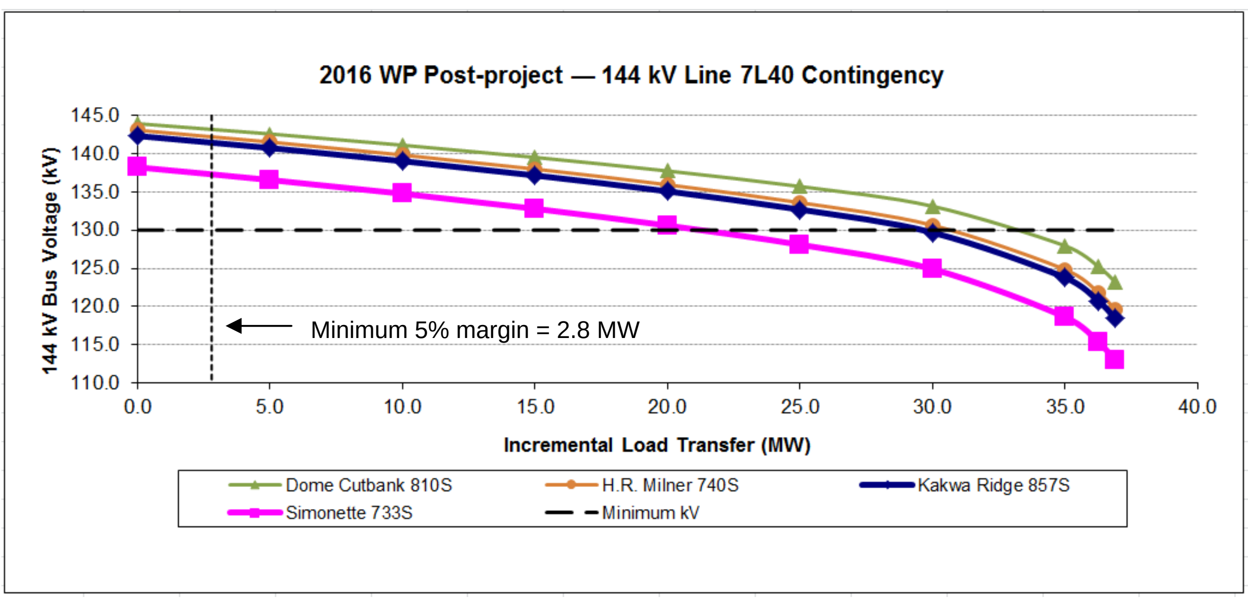


Figure C-3: PV Curves for the 144 kV Line 7L80 Contingency